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How do Students Conceptual Understand Using Augmented Reality Video Animation? An Empirical and Theoretical Overview

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ABSTRACT

Technology integration in education has become crucial in enhancing students' conceptual understanding, especially in abstract subjects such as science. Many schools, such as SDN 1 Bunulrejo, struggle to optimize available technological resources due to insufficient training and limited use of interactive media. Current teaching methods often rely heavily on traditional approaches like lectures and textbooks, which fail to provide students with a deep and engaging learning experience. This study investigates using Augmented Reality (AR) combined with video animation as a teaching tool to improve students' conceptual understanding, motivation, and engagement in learning science, specifically on the topic of "Plants and the Environment" to address this issue. The study employed AR-based animated video media to deliver instructional content using a quasi-experimental design with a pre-test and post-test on a sample of 36 fourth-grade students. The findings revealed a significant improvement in students' conceptual understanding and increased engagement after the implementation of AR media. This research contributes to developing innovative teaching methods in elementary education and offers practical insights into how AR and animation can enhance learning outcomes.

Keywords: Augmented reality, concept understanding, natural science

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INTRODUCTION

Building a strong conceptual foundation in elementary science is essential for students' long-term academic growth. DiSessa (2014) emphasizes that students struggle to apply knowledge across subjects without a solid grasp of fundamental concepts. As Graulich and Schween (2018) notes, memorization

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without understanding often limits comprehension; for example, students may perform arithmetic operations mechanically without understanding place values (Gilmore et al., 2018).

At SDN 1 Bunulrejo, teachers primarily use lectures, textbooks, and PowerPoint despite having access to technological resources such as computer labs, tablets, and Wi-Fi. With limited interactivity, this traditional approach constrains students' deeper learning experiences (Lindgren et al., 2016; Chen, 2020). Studies suggest that limited technology use in classrooms often results from teachers' lack of technical training (Ibáñez & Delgado-Kloos, 2018; Ramnarain, 2014).

Augmented Reality (AR) can address these gaps by vividly illustrating abstract scientific concepts. For instance, AR technology can help students better understand complex topics like photosynthesis and ecosystems, transforming abstract ideas into engaging, immersive experiences (Ibáñez & Delgado-Kloos, 2018; Weng et al., 2020).

PROBLEM STATEMENT

Building a strong foundation in elementary science is essential for students' academic growth, yet instructional methods at SDN 1 Bunulrejo remain largely traditional, relying on lectures, textbooks, and PowerPoint slides. Despite access to computer labs, tablets, and Wi-Fi, this approach limits deeper learning experiences. Studies indicate that limited technology use often results from insufficient teacher training, preventing effective integration of interactive resources. Consequently, students may struggle to understand and apply core concepts, impacting comprehension across subjects.

Augmented Reality (AR) has the potential to address these gaps by illustrating complex scientific ideas, such as photosynthesis, in engaging, immersive ways. By enhancing concept clarity and interactivity, AR could transform abstract ideas into accessible experiences, supporting students in developing a stronger scientific foundation for future academic success.

RESEARCH QUESTIONS

This study explores how Augmented Reality (AR) impacts elementary students' understanding and engagement with basic science concepts at SDN 1 Bunulrejo. Using a quasi-experimental pretest-posttest design, 36 fourth-grade students participated in an AR-based learning session on the theme "Plants as Life Sources." Initial assessments revealed that students skilled in technology use and inclined toward interactive learning scored an average of 55.083 on the pre-test. Post-AR session scores rose significantly to an average of 80.417, illustrating a substantial improvement in understanding plant concepts.

The AR session, featuring animated videos, engaged students through immersive 3D interactions that align with findings from Azuma et al. (2001) and Alzahrani (2020), who noted AR's motivational benefits. Student satisfaction reached 94.75%, reflecting

high engagement and observational data confirmed AR's positive role in fostering comprehension and motivation. The Wilcoxon Signed Rank Test revealed a statistically significant increase in scores ($p = 0.000 < 0.05$), supporting the hypothesis that AR effectively enhances conceptual understanding by visualizing complex ideas, reducing the cognitive load (Buchner et al., 2022), and making abstract concepts more accessible (Akçayır & Akçayır, 2017; Ibáñez & Delgado-Kloos, 2018).

Aligned with studies by Gargrish et al. (2022) and Tsai and Wang (2019), these results affirm AR's educational benefits in elementary settings, especially in enhancing conceptual understanding and engagement. However, further research is suggested to examine AR's impact across different subjects and its long-term influence on learning retention.

CONCLUSION

This study concludes that integrating Augmented Reality (AR) video animations into elementary science education significantly enhances students' conceptual understanding. The analysis showed a marked improvement in post-test scores, supporting the effectiveness of AR-based learning. Student engagement and motivation were notably high. While promising, the study acknowledges limitations such as unequal access to AR devices and adaptation challenges. Future research should address these issues and explore AR's potential in other subjects. Overall, AR technology offers a dynamic, interactive approach that improves comprehension, providing valuable insights for its application in elementary education.

IMPLICATION

These findings highlight the potential of AR video animation as an effective tool for teaching complex concepts, making learning more engaging and helping students understand the material better. They also suggest opportunities for further research on AR's application across different disciplines and the development of diverse, enriched learning materials.

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